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*THE EDUCATIONAL AND INDUSTRIAL VALUE OF SCIENCE.**

ON the occasion of the formal dedication of a building devoted to the teaching of science, it is fitting that something should be said respecting the claims of science to such generous recognition and such ample provision for its cultivation in a young university, established by a Commonwealth itself still 'in its teens.' In the Atlantic States the stagecoach is almost obsolete. It has given way to the railway, and it is an open question whether transportation by steam will not ultimately yield to the agile trolley wheel. So the old-time college, devoted to the ancient languages, mathematics, and a little leaven of moral philosophy, with its slow-going ways, its simple outfit of benches, a teacher's desk and a chapel, has been superseded by the modern university, with its complex organization, its multiplicity of courses and subjects of study, its laboratories and equipment, and its corps of trained, eager, alert instructors, who are not expected to teach a book only, but to add to the sum of human knowledge, and to awaken in kindred spirits at least an enthusiasm for study, a delight in investigation, which has proved the most efficient stimulus to high intellectual attainments. The erection of the Hale Scientific Building indicates that the University of Colorado aims to pursue its way untrammeled by ancient traditions, with the spirit of modern ideas in education, and in touch with the most progressive institutions of learning.

Shall we pause a moment to inquire what has wrought this change in the aims and methods of higher education in the United States? What new conditions make it possible for a young university like that at Chicago to forge toward the front in two or three short years? Universities have always been considered as institutions of slow growth. They represent the accretions of

*Read at Boulder, Col., March 9, 1895.

years and centuries even, if we broaden our view sufficiently to include those of Europe. Such indeed are the customs, the traditions and the general policy of a great university with decades or centuries of history behind it. Every ancient seat of learning has a character peculiarly its own. There is an indescribable charm attaching to crumbling, ivy-cumbered walls; to time-stained libraries, that point with motionless fingers back toward their more silent authors; a subtle influence in the steady gaze of the famous sons of the college, as they look down on the younger generation from the deepening canvas in the memorial portrait hall. Who that has a fibre of his soul tuned to vibrate in unison with melodies of the past can fail to feel an energetic thrill as he stands among the distinguished sons of the Harvard of former years ranged around the walls of 'Memorial Hall,' or as he walks softly through the portrait gallery of Christ Church College in Oxford? These influences are not to be despised. They are an inheritance from the long past and are still potent. Addison still walks under the arching trees by the quiet stream at the back of Magdalen College; Wolsey and Wesley and Gladstone still linger in the noble hall of Christ Church; and Newton's rooms remain near the imposing gateway of Trinity College in Cambridge. I love to step within the charmed circle of such subtle influences, to yield to the magic spell, and to count myself a part of all this glorious past.

But the modern spirit prevades the oldest institutions, and great seats of learning are rising on new foundations. In both old and new the most marked characteristic of the teaching of the present is the scientific method. It has pervaded every department and has proved the leaven that, being taken and hid in the ancient curriculum, as inert as the three measures of meal, has leavened the whole. Till the introduction of serious scientific study with laboratory facilities, the educational methods which had prevailed for centuries were still current. As late as twenty-five years ago in a respectable New England college it was not possible for a student to learn his science by means of laboratory study. All this has now changed, and no less important a change has taken place in the teaching of language and literature. It is significant that this advance in pedagogical practice, the introduction of the method by investigation as compared with mere memoriter acquisition, has been coincident with the introduction of the serious study of science into our American colleges and universities. Twenty-five years ago the Massachusetts Institute of Technology led the way by introducing the physical laboratory into the study of physics. Some progress had already been made in the teaching of chemistry by direct contact with chemical reactions at the work table. It is only fifty years since Liebig inaugurated the system of studying chemistry by the laboratory method, and it is highly probable that the physical laboratory established by William B. Rogers in Boston marked the introduction into the regular curriculum of instruction in physics by experiment.* I venture to say that no greater success has followed any new departure in education. The physical laboratory is now a necessary part of every institution devoted to higher learning; its growth has been phenomenal. Enormous sums of money have been expended for physical laboratories and their equipment. The example set by this oldest branch of science has had a most beneficent influence in several directions. It has improved the quality of the work in the secondary schools. The physical laboratory is now a necessary part of every first-class high school equipment. It has also stimulated and advanced original work. Every

* Professor Mendenhall in *The Quarterly Calendar* of the University of Chicago, August, 1894.

instructor competent to fill a professor's chair in physics is now expected to add something to the stock of knowledge by his independent investigations. It has thus made graduate instruction possible in American universities, a movement having the most hopeful outlook and of the most profound educational import.

A third and most complete leavening influence is that the method by experiment and original investigation adopted by science has compelled other departments of learning to become its imitators, so that now the laboratory method prevails in nearly every department of learning. This result is too patent to be questioned even. Psychology, language and history have yielded to the powerful example set by physics and chemistry. Archæology has its work-room, its laboratory; language its photographs, its projections, its casts and reproduction of ancient life and times; while psychology has appropriated not only the methods, but the apparatus of the physicist.

Now a movement which has been such a powerful operator in solving the problem of education in every branch of learning has a significant value in the intellectual training of American youth. In fact, the value of science in any system of liberal education is so generally admitted that it is an almost needless expenditure of energy to enter into a discussion relative to its merits. It is no new comer for whom room is benevolently or patronizingly made in order that it may display its powers and demonstrate its worth. It acknowledges other claimants as peers, but admits no superiors. It came long ago to stay.

I should like to point out two or three aspects of the study and pursuit of science not often alluded to or recognized, but on which I lay much stress. The first relates to the cultivation and chastening of the faculty of imagination. Sir Benjamin Brodie said in a presidential address to the Royal Society many years ago: "Physical investigation, more than anything besides, helps to teach us the actual value and right use of the imagination—of that wondrous faculty which, left to ramble uncontrolled, leads us astray into a wilderness of perplexities and errors, a land of mists and shadows; but which, properly controlled by experience and reflection, becomes the noblest attribute of man, the source of poetic genius, the instrument of discovery in science, without the aid of which Newton would never have invented fluxions, nor Davy have decomposed the earths and alkalies, nor would Columbus have found another continent." It would be a grievous mistake to suppose that the cultivation of science contributes only to accuracy and exactness; to the development of the habit and power of observation, and to the education of the reasoning faculty as applied to the concrete—to the objects and phenomena of nature. All of these constitute a valuable training and are demonstrable results of an honest effort to understand and coördinate the phenomena of nature. But as soon as the student of science passes beyond the mere elements he must train himself to the habit of conceiving things which "eye hath not seen, nor ear heard, nor have entered into the heart of man." He must emancipate himself as much as possible from the domination of his sensations, and must learn that sense-perceptions should not be projected into the outer world of nature, but that they are only symbols of objective phenomena presented to consciousness, which the imagination, aided by reason and reflection, must interpret. Not only is the imagination called into activity by the common occurrences of the natural world lying along the level and the horizon of man's experience, but it is powerfully stimulated by the more remote phenomena above him and below him. Man contemplates the starry firmament on high, the spangled heavens,

flecked with barely discernible patches of light; he puts together these trembling nebulæ, as the dismembered parts of a puzzle panorama of the heavens; and out of them all, triumphant over time and space, he constructs a nebular theory of the visible universe. He thus concludes that the various bodies of the solar system "once formed parts of the same undislocated mass; that matter in a nebulous form preceded matter in a dense form; that as the ages rolled away, heat was wasted, condensation followed, planets were detached, and that finally the chief portion of the fiery cloud reached, by self-compression, the magnitude and density of our sun" (Tyndall).

On the one hand, the telescope and spectroscope are aids to the imagination in penetrating the almost inscrutable mystery of the skies; on the other, the microscope enables it to descend somewhat into the no less limitless underworld, and to sink the exploring plummet to depths as far removed from the field of the microscope as the celestial boundaries are beyond the vision attained by the telescope.

How wonderful, also, is the ethereal medium which man's imagination has constructed, the vehicle of the energy wafted to us from sun and stars! To the mental vision this medium fills all space and quivers with radiant energy—that winged Mercury, bearing messages to man from all the worlds on high. Even electrical and magnetic phenomena are utterly inexplicable without it. The imagination of Faraday, of Maxwell, and of Hertz, has woven out of it a texture of lines of electric and magnetic force, which are as real to the electrician as the machines and conductors which he mantles with them. Every conductor conveying a current, every permanent or electromagnet, is surrounded with its system of lines of force in the ether. And when an alternating current traverses a conductor these lines of magnetic force are propagated outward from it in waves which spread with the velocity of light. In fact, they are identical with light objectively, except in point of wave-length. Thus the theory, imagined by Maxwell with the insight of marvelous genius, and confirmed later by the classical experiments of the lamented Hertz, is now accepted doctrine by physicists the world over. The existence of the ether is now seen to be a necessary consequence of Roemer's discovery in 1676 of the finite speed of light. For the transmission of light is the transmission of energy; and a medium of transmission is a necessary postulate as the repository of this energy during the time of transmission. Newton imagined the light-giving body projecting minute particles, or corpuscles, through space and carrying their energy with them as a bullet carries its energy to the mark. These entering the eye excite vision by impact upon the retina. But Newton's corpuscular theory failed because of its final complexity and the crucial test applied to it by the great experimenter, Foucault.

The undulatory theory, on the other hand, requires a continuous medium, and the energy is handed along from particle to particle as an undulation. In this way energy is conveyed by sound and by water-waves across the surface of the sea. According to this theory, a luminous body is the center or source of a disturbance in the ether which is propagated in waves through space. They are electromagnetic in origin, travel with the velocity of light, and entering the eye excite the sense of vision. Thus far have we been helped along by the imagination of genius and the contributory aid of experiment. Mean and unfruitful indeed is the science which has not been enriched, extended and vivified by the scientific imagination. Where dull reason halts and the understanding is confounded by appalling obstacles, imagination overleaps them all and the barriers are dissolved

away. The boundaries of scientific inquiry have thus been moved forward and new territory has been added to the cultivated domain.

Again, let me direct your attention to another feature attending the prosecution of scientific research. While it is undoubtedly destructive of credulity, and is perhaps but a weak ally of faith, it is nevertheless a powerful promoter of honesty. The object which the scientific investigator sets before him is to ascertain the truth. He is devoted to it and pursues it with unremitting toil. But this is not all. He not only seeks truth, but he must be true himself. It is difficult to conceive of any circumstances which would induce him to play a dishonest part in scientific research. He has every inducement not only to accuracy but to honesty. He may unwittingly blunder and fall into error, but if he is untrue he is certain to be exposed. No discovery is permitted to go unverified. It must undergo the searching examination of scientific inquiry. The investigator must submit his data and must seek to have his results confirmed. There is, therefore, every inducement for him to be absolutely truthful. This condition imposes upon him also the habit of conservatism and moderation in statement. He is not expected to plead a cause or to make the most of the occasion for himself. In this regard his position is in contrast with those whose profession makes them the allies of faith, but whose moderation is not always known to all men; for their assertions are not brought to the touchstone of revision and justification, and the released word flies over the unguarded wall. The habit of the scientific investigator is to subject every question to the scrutiny of reason and to weigh probabilities. He obeys the injunction, "Prove all things; hold fast that which is good." He respects conscience, but has no use for credulity. He exhibits devotion to principle, but dogmatism, whether in science or religion, has no place in his creed. He looks not only upon the things which are seen, but also upon the things which are unseen. You may suffer me to remind you that the most noted American atheist is not a man of science, while one of the forceful books of modern times, 'The Unseen Universe,' which aims to lay a foundation for belief in a future life without the aid of inspiration, was written by two distinguished physicists. Science examines the foundations of belief. It takes nothing from mere tradition, on authority, nor because it is an inheritance from the past. It admits its own limitations and the somewhat circumscribed boundaries set to the field of its inquiries; but within this province it seeks to ascertain only the truth. It recognizes not only the promise and potency of matter, but the power which makes for righteousness.

Turning now to some more practical matters, it is strongly urged that the study of science should begin early, before the taste for such study has become atrophied by too excessive attention to language and mathematics. It is a fact established by observation that if a student gets his first introduction to science only after he is well along in his college course he comes to it with a mental inaptitude that often produces discouragement and precludes the possibility of much satisfaction in its pursuit. The procedure in scientific study, especially when it includes the method of the laboratory, is so radically different from that involved in the study of language that one trained only in the latter finds himself in a foreign field when he enters the former. The study of language, considered merely as the symbolism of thought, or the instrument for its expression, is most valuable and essential. You shall hear no word from me designed to depreciate the value of linguistic study and training. It is rather

to be deprecated that scientific men do not generally pay more attention to the formation of a correct English style, and do not oftener acquire the ability to express the results of their studies in more elegant English diction. On the other hand, an exclusive training in the so-called humanities leaves the student unsymmetrically developed. The elementary study of language is largely a study of the forms and symbols of speech; to the young student, at least, the thought is altogether a secondary consideration. Mathematics furnishes a training in the relations of abstract number, and in the manipulation of symbols invented to facilitate operations expressing the relations between related quantities. It is not only a valuable agency in mental development, but it is a powerful instrument for the investigation of phenomena in those branches of science to which applied mathematics is indispensable. Science has more to do than either language or mathematics with objective phenomena. The student of science soon finds that he has a new set of relationships with which to deal. He may be familiar with mathematical theorems and solutions, but his first difficulty is to see the points of attachment of mathematics to the facts of physical science. He is armed with a weapon of most modern design and exquisite workmanship, and he has possibly obtained some skill in target practice, but he has no eye for game. He may be too short-sighted to see that there is any game even.

Skill in the use of scientific methods of reasoning and acquirement comes only after the mind has been kept for some time in contact with science, so that it has acquired the scientific spirit and aptitude. The preparation for the scientific work of the university should therefore begin in the secondary schools. Continuity in scientific acquisition is as essential as in that of language or mathematics. While six, or even eight, years are given to language in the high school, counting the four years with three studies each as twelve, it is thought by some to be an evidence of great magnanimity if two years out of the twelve are given over to the mere elements of physical and biological science. It is obvious to any careful observer that much improvement has been made in the teaching of science in secondary schools within the last few years. More competent teachers are employed, laboratory facilities have been provided, better manuals have been written, and the tone of the science department has been improved by the fact that preparation in science at last leads to something further in the university. This continuity in the pursuit of scientific studies has already furnished qualified teachers for the lower schools. What wonder if the teaching of science in the schools should not have proved as fruitful as was once hoped! Till recently language and mathematics have had the training of the teachers throughout our whole educational history, and if science secured entrance to a secondary school at all it got there in a secondary place. All that science asks is to be placed on equal footing with other lines of study. It demands no preferences and is strenuous that no ultimate bounties shall be extended to other branches. There should be no favored nations in the world of education. It recognizes no excellences in language or literature to justify superior awards at graduation. There are no sacred vessels in education which science may not touch, no shibboleth which she cannot pronounce, no holy of holies which she should be forbidden to enter. The ideal culture course is not all science, not all language, and not all mathematics, but a judicious combination of these and other branches. It would be no less logical for one to make one's course chiefly science than to make it chiefly language; but when the student has

successfully completed his course, making due allowance for personal differences and needs, no reason seems to me valid for not crowning the equivalent work of all with the same degree.

Reference to the other aspect of my subject has, perhaps, been too long delayed. Science has not only educational value of a high order, but industrial applications as well. Discovery and scientific training precede invention. The quality of mind that discovers the laws of nature is of a higher order than that which makes application of them. The genius of Faraday and Henry, who discovered the laws of magnetic induction, must not be dimmed or diminished by reduction to the level of even the greatest living inventors. The contributions of these men to the well-being, comfort and happiness of mankind cannot be over-estimated. They laid the foundation in magnificent discoveries of those splendid applications which have dazzled the world in recent years. So thoroughly intrenched in theory and practice are Faraday's conceptions at the present day that they enter into every design of motor or dynamo. They have been shot through the entire body of practice and are intertwined with every thread of electrical thought.

On the other hand, one must not fail to note that the wonderful applications of science have reacted in a favorable way upon theory and investigation. They have proved an effective stimulus to research and have furnished a multitude of problems for original investigation. Scientific discovery and inventions involving scientific laws are two handmaids of national improvement. They are larger agencies for the advance of modern civilization than any others. Astronomy has made splendid contributions to navigation since Galileo suffered for teaching that the earth revolves daily on its axis and yearly round the sun. It has also made possible modern chronometry by giving us the accurate unit of time. The contributions of modern chemistry are so numerous and so important that it is difficult to particularize. It has taken a useless refuse of the gas retort and converted it into resplendent dyes that rival the gorgeous colors of the rainbow. It has improved and cheapened the processes of manufacturing iron till the cost of the ore and the fuel control the price of the product; and old establishments, far removed from the cheap supply of either, have had to succumb to the march of events.

Bacteriology, the ally of chemistry, working largely by chemical methods, gives the fairest promise of discovering the cause and the prevention of disease. Its beneficent aim now is to devise methods of securing immunity from the most deadly diseases, whose ravages are greater than those of great civil wars. Important discoveries in this direction are impending, and medicine is fast becoming a science instead of a body of empirical rules.

Bacteriology has already isolated and identified a large number of pathogenic or disease-producing germs and hopes in time to corral them. It has demonstrated that disease is not due simply to the presence of the bacillus, but to the specific poison resulting from its growth. It has added consumption and pneumonia to the list of infectious diseases; and the discovery of the cause is a long stride toward the goal of prevention.

The specific direction in which the large body of scientific discovery is turned to practical account is in the several branches of engineering. The civil, mechanical, electrical and mining engineers are the prophets of the new civilization. They have pierced the highest mountains; hung highways over the most dizzy cañons; constructed a rushing steed that feeds on the compressed vegetation of the carboniferous age and wearies not; they have brought the nations

together so that the great oceans scarcely separate them; they have bound continents together by wonderful cables embedded in slimy ooze at the bottom of the sea. Eiffel reared his tower a thousand feet to pierce the sky; Baker projected three of his out 1700 feet horizontally without staging to bridge the Firth of Forth; and over them fly four hundred trains daily without slackening speed; each span is longer than the Brooklyn bridge, and there are three spans. The seven wonders of the world have become seventy, and still the modern engineer pauses not. He now soberly contemplates a deep waterway from the great Northwest to the Atlantic coast. He has not even abandoned the problem of aerial navigation, but attacks it on a new principle. Archimedes is said to have declared that if he had a place for a fulcrum he could move the world. Professor Vernon Boys has just weighed the earth and determined its density to the third decimal place by means of two gilded balls suspended by a fiber of quartz, finer and stronger than a spider's web. Not content that the earth yields her yearly increase, and that the sea furnishes abundant food, the engineer burrows into the eternal hills and seeks for hid treasures in the depths of the earth. The gold and the silver he wishes to be his also. He even establishes an electric plant some 1600 feet underground, converts the power of the descending stream of water into electric energy, and sends it back to the surface for further service.

He has contemplated the colossal cataract at Niagara not only as a display of natural grandeur, but as an example of unlimited power running to waste. At last he is nearly ready to recover a small part of this power and to transmit it to distant cities, where it may turn the wheels of industry or be transmuted into light. No grander problems remain for solution than those even now confronting the electrical engineer. The swiftness with which he has already passed from one almost insurmountable task to another has amazed no one more than those most familiar with the means employed. If electrical engineering is still in its infancy it is certainly a giant infant. It has long since outgrown its toys. With the nerve and audacity of vigorous young manhood it quails before no obstacles and acknowledges no impossibilities. Having practically banished the plodding horse from the street railway, it is getting ready to enter the lists against the locomotive. If your city is not seated near a source of power it will undertake to bring the power to you. The mountain can not go to the city, but the city can go to the mountain for its power. Electrical engineering stands at the door of the twentieth century, ready to accept the tasks that it imposes, and eager to enter upon a new period of discovery and application.

A marked feature of educational history in the United States for the past twenty-five years is the rapid increase in engineering schools, partly on independent foundations, and partly as a professional department of universities. Of this latter class the only ones existing a quarter of a century ago, so far as I know, were the Lawrence Scientific School at Harvard, the Sheffield Scientific School at Yale, and the courses in Civil Engineering in the Universities of Pennsylvania and Michigan. The first two, as their name implies, were devoted quite as much to the teaching of pure science as to engineering. They attracted but little attention, and in fact the Lawrence School had but a moribund existence for many years after the establishment of the Institute of Technology in Boston. Recently it has had new vigor infused into it and has profited by the growing interest in engineering education. Cornell and the State Universities have led the way in the establishment of engineering schools, and

their example has been followed in a way that demonstrates more completely than anything else could that a popular demand exists for engineering instruction.

Civil engineering came into the University of Michigan in 1853, with the late Dr. Alexander Winchell, as an adjunct of Physics. It had an independent instructor in 1857 in the person of Professor De Volson Wood, who is well known in the profession at the present day. Mining engineering followed in 1875. Mechanical engineering was introduced by a professor detailed from the U. S. Navy Department in 1881. Finally the course in electrical engineering was begun in 1889. The success of this last course has more than justified its introduction, as the roster of students in it already exceeds that of either of the older engineering courses. This growth is attributable to the popular interest in the subject.

The engineering courses are primarily professional as distinguished from the literary curriculum. They lay the foundation in theory and a moderate amount of practice for distinguished careers in a private professional capacity and at the same time in the service of the State. A large portion of the graduates of American technical schools have been very successful in their professional career. The presence of a considerable body of trained engineers, distributed throughout the country, has had a marked influence on the number and character of the public improvements made. If a great commonwealth is justified in maintaining an institution of higher learning because of the public weal, as I fully believe it is, then the maintenance of schools of engineering is approved by considerations of high public interest.

From an educational point of view, the courses in engineering furnish a thorough and by no means narrow intellectual training. The rigid discipline in pure and applied mathematics, the courses in physics and chemistry, the attention given to modern languages, are all additional to the special instruction in engineering studies; and while they serve as a foundation for them their value as a means of intellectual culture are just as great as if they were pursued for this purpose alone. An eminent scholar, Professor Ritter of Germany, has recently testified to the success of technical education in the United States and says that the Americans have outdone Europeans in this regard. The theoretical side of the technical branches Professor Ritter believes to be less solid here than in Germany; but against this defect he sets the "truly grand achievements in engineering and machine construction in the United States." In the normal growth of our engineering courses they will gradually be strengthened on the theoretical side. At the same time we can not guard too carefully against the crowding out of that amount of practice obtainable from a well-equipped engineering laboratory and such tests of actual machinery as may be accessible. The highest justification of the American plan of engineering schools is to be found in the prominent part taken by comparatively recent graduates in the most difficult undertakings of engineering practice.

In the provision for science and engineering, indicated by the dedication of the Hale Scientific Building, the University of Colorado is following the best examples of American education. It has made a noble beginning in the cultivation of science, the augury we may be permitted to hope of a brilliant future. A wide world of discovery yet remains. The remark of an eminent physicist that the future discoveries of physical science are to be looked for in the sixth place of decimals is rendered rather ludicrous by the recent discovery of 'Argon,' a new constituent of the atmosphere, composing about two per cent. of its weight. If the air we breathe can furnish a new and al-

most unsuspected element, what other surprises may hide in equally common things? The twitching of a dead frog's leg a hundred years ago started a train of discoveries in electricity that have revolutionized the world. But Galvani was not the first anatomist who used the frog as illustrative material. Science knows no ultimate limits beyond which she may not go. The mountains of Colorado are not yet exhausted of their precious metals, nor has nature yet thrown up her hands as a signal that she no longer resists the uncovering of all her treasure.

I bear to you the congratulations of the Mother of State Universities, and the wish that this institution may be an intellectual light attracting the youths of Colorado, and a glory to this great Commonwealth.

HENRY S. CARHART.
UNIVERSITY OF MICHIGAN.

THE GROWTH OF FIRST-BORN CHILDREN.

DURING the year 1892 I made arrangements for a series of measurements of school children, one of the objects of which was the determination of any existing difference between the growth of first-born and later-born children. The measurements were taken in Toronto, under the direction of Dr. A. F. Chamberlain, and in Oakland, Cal., through the kindness of Professor Earl Barnes. The following table contains the results of the observations taken in Oakland.

The columns named 'Differences' gives the amount to be added to the average stature and weight in order to obtain the statures and weights of first-born and later-born children. The figures printed in parenthesis designate the numbers of individuals measured.

STATURES OF BOYS IN MILLIMETERS.

Ages. Years.	Average Stature.	Differences Between Average Stature and Stature of: First Born Children.	Second Born Children.	Third Born Children.	Fourth Born Children.	Later Born Children.
6.5	1137 (145)	+ 7 (30)	+ 7 (39)	—13 (25)	— 2 (16)	— 5 (33)
7.5	1180 (197)	+11 (49)	— 4 (42)	+13 (31)	± 0 (24)	—10 (46)
8.5	1249 (234)	— 3 (57)	— 7 (54)	— 1 (32)	—18 (25)	—21 (61)
9.5	1283 (220)	+ 2 (57)	— 2 (47)	+ 5 (38)	+ 5 (23)	+ 1 (46)
10.5	1334 (243)	± 0 (66)	+33 (49)	—18 (41)	—15 (35)	— 8 (47)
11.5	1379 (208)	— 1 (58)	+ 1 (39)	+16 (32)	—13 (27)	— 1 (45)
12.5	1426 (230)	+20 (66)	— 1 (47)	— 4 (38)	— 5 (36)	—19 (41)
13.5	1482 (184)	+16 (54)	+10 (43)	+16 (28)	—31 (26)	—25 (30)
14.5	1556 (163)	+11 (46)	—19 (40)	+ 4 (27)	± 0 (25)	+ 8 (24)
15.5	1632 (118)	+ 6 (35)	+ 8 (29)	—18 (22)	—14 (15)	+ 4 (17)
16.5	1668 (116)	—19 (29)	+17 (30)	+21 (18)	—20 (13)	± 0 (25)
Average Differences.		+4.5	+4.0	+1.9	—7.9	—6.9

STATURES OF GIRLS IN MILLIMETERS.

Ages. Years.	Average Stature.	Difference Between Average Stature and Stature of: First Born Children.	Second Born Children.	Third Born Children.	Fourth Born Children.	Later Born Children.
6.5	1125 (113)	+11 (32)	± 0 (28)	— 9 (15)	—16 (10)	— 1 (28)
7.5	1175 (199)	+ 8 (49)	— 1 (40)	+ 3 (44)	— 4 (24)	—11 (42)
8.5	1226 (221)	+14 (52)	—11 (46)	— 9 (43)	+13 (19)	— 4 (61)
9.5	1277 (252)	— 4 (65)	— 3 (57)	+14 (47)	—17 (21)	+ 5 (50)
10.5	1335 (224)	+ 7 (59)	— 2 (46)	+15 (28)	— 6 (26)	—11 (59)
11.5	1389 (226)	+12 (52)	+10 (41)	— 3 (32)	+ 3 (34)	—14 (61)
12.5	1450 (283)	+ 3 (65)	+14 (56)	— 1 (55)	+ 7 (40)	+ 8 (67)
13.5	1516 (222)	— 3 (62)	+ 9 (48)	—19 (38)	+ 6 (29)	+ 9 (45)
14.5	1566 (241)	+ 9 (61)	± 0 (68)	— 8 (38)	—17 (23)	— 1 (49)
15.5	1577 (170)	— 2 (42)	+11 (36)	— 6 (32)	— 1 (19)	— 5 (41)
16.5	1597 (127)	+15 (30)	—38 (28)	— 3 (23)	— 1 (14)	—18 (32)
17.5	1597 (99)	+10 (30)	—21 (19)	— 8 (19)	± 0 (15)	+14 (16)
18 & older	1602 (82)	+12 (27)	— 5 (20)	—25 (10)	—10 (9)	— 1 (16)
Average Differences.		+7.1	—2.8	—4.5	—3.3	—2.3

WEIGHTS OF BOYS IN POUNDS.

Ages. Years.	Average Weight.	DIFFERENCE BETWEEN AVERAGE WEIGHT AND WEIGHTS OF				
		First Born Children.	Second Born Children.	Third Born Children.	Fourth Born Children.	Later Born Children
6.5	47.7 (147)	—0.3 (28)	+0.7 (38)	+0.1 (26)	—0.1 (18)	—0.5 (35)
7.5	51.7 (191)	+1.1 (48)	—0.6 (42)	+0.1 (32)	—1.0 (21)	±0.0 (44)
8.5	57.3 (229)	—0.3 (58)	+0.2 (52)	+0.5 (32)	+0.7 (26)	—0.6 (57)
9.5	62.2 (212)	—0.4 (57)	+0.1 (45)	—0.2 (36)	—0.2 (22)	—0.1 (43)
10.5	69.0 (235)	—1.6 (64)	+5.4 (47)	—2.1 (39)	—1.4 (36)	—0.1 (44)
11.5	74.8 (206)	+1.0 (58)	—0.9 (38)	+1.2 (33)	—0.9 (27)	—0.3 (44)
12.5	81.6 (224)	+2.1 (64)	+1.2 (46)	—0.4 (37)	—2.6 (34)	—1.8 (41)
13.5	89.1 (185)	+2.0 (50)	+2.3 (46)	+4.1 (28)	—8.9 (32)	—2.5 (32)
14.5	105.1 (160)	+1.6 (47)	—0.7 (38)	—0.2 (26)	—1.4 (23)	+0.5 (25)
15.5	119.5 (114)	+3.0 (33)	—1.7 (27)	+0.1 (21)	+0.8 (15)	+1.8 (17)
Average Differences.		+0.82	+0.60	+0.32	—1.58	—0.44

WEIGHTS OF GIRLS IN POUNDS.

Ages. Years.	Average Weight.	DIFFERENCE BETWEEN AVERAGE WEIGHT AND WEIGHTS OF				
		First Born Children.	Second Born Children.	Third Born Children.	Fourth Born Children.	Later Born Children.
6.5	45.7 (123)	±0.0 (31)	+0.9 (30)	—1.0 (15)	—1.2 (10)	+0.4 (32)
7.5	49.6 (186)	—0.1 (45)	+0.6 (37)	—0.1 (42)	—0.5 (23)	+0.1 (39)
8.5	55.7 (217)	+0.6 (50)	+0.3 (45)	—1.1 (42)	+0.8 (21)	±0.0 (59)
9.5	60.0 (242)	—1.5 (64)	+0.3 (57)	+2.1 (48)	—3.1 (22)	+1.0 (46)
10.5	66.8 (221)	+0.4 (57)	—0.8 (45)	—1.8 (28)	+2.5 (25)	—1.0 (60)
11.5	74.3 (222)	+2.1 (50)	—1.2 (41)	+0.4 (31)	+0.7 (32)	—1.2 (62)
12.5	84.2 (280)	+1.2 (67)	+2.6 (56)	—3.2 (54)	—0.4 (39)	—0.2 (64)
13.5	94.2 (220)	—0.9 (62)	+3.9 (47)	—2.6 (37)	+0.3 (29)	—1.2 (45)
14.5	105.8 (235)	+0.4 (60)	+1.3 (64)	—4.2 (35)	—1.4 (25)	+1.7 (49)
15.5	110.7 (165)	+0.1 (41)	+0.1 (32)	—3.5 (33)	+2.4 (19)	+1.2 (40)
16.5	116.5 (124)	+7.9 (29)	—1.5 (27)	—3.9 (22)	—7.5 (14)	—0.1 (32)
17.5	117.4 (99)	+1.9 (30)	—0.5 (18)	—3.2 (19)	+4.1 (15)	—1.2 (16)
18 & older	118.3 (82)	+2.4 (27)	+0.4 (20)	—0.1 (10)	—6.0 (9)	—1.1 (16)
Average Differences.		+1.12	+0.48	—1.71	—0.72	—0.12

It appears from these four tables that first-born children exceed later-born children in stature as well as in weight; that this difference prevails from the sixth year until the adult state in females, and from the sixth year to the fifteenth in males. The material is not sufficiently extensive to show if the same is true of the adult males. Although the difference is not large, it occurs with such regularity that there can be no doubt as to the reality of the phenomenon. The available material is not very extensive, and the subdivision into five classes makes each class so small that the existing irregularities are not surprising. A preliminary investigation of the Toronto material is entirely in accord with the results derived from the Oakland material, the difference in favor of the first-born being, if anything, more marked.

We are, therefore, justified in grouping the measurements into two classes: first-born individuals and later-born individuals. This increases the difference of stature of the two groups to 10 mm. in girls, to 7 mm. in boys, and the differences of weight to 1.6 pounds in girls and to 1.2 pounds in boys. The tables seem to indicate that second-born children exceed somewhat later-born children in stature and weight, but the material is not sufficiently extensive to allow us to make a safe deduction on this question.

It would seem likely that the greater

vigor of the mother at the time of birth of the first child and the greater care bestowed upon the first child during its early childhood may be the cause of the phenomenon. The cares of the increasing household tend to weaken the mother and to decrease the amount of motherly attention devoted to later-born children. It is remarkable that the relation of size existing at the time of birth should be reversed in later life; it having been shown that the weight and length of new-born infants increases from the first-born to the later-born children.*

A comparison between the above table and others shows that the children of Oakland exceed those of all other cities of the United States in which measurements have been made, in height as well as in weight.

FRANZ BOAS.

WASHINGTON, D. C.

CURRENT NOTES ON ANTHROPOLOGY (*V.*).

SUBDIVISIONS OF THE STONE AGE.

THOSE students who make use of Mortillet's excellent manual 'Le Préhistorique Antiquité de l'Homme,' now a little out of date, will be glad to learn the subdivisions of prehistoric time as taught this winter in his courses at the École d' Anthropologie, of Paris.

He divides the Stone Age into three 'periods,' covering six 'epochs.' The oldest is the eolithic, beginning with the 'Thenaysienne,' referring to the rather doubtful flints from the station of Thenay. Above this is the 'Puycournienne,' based on the finds at Puy-Courny. The palæolithic epochs remain the same as given in his manual, to wit: beginning with the oldest, the Chelleenne, the Acheuleenne, the Moustérienne, the Solutréenne and the Magdalenienne. Then follow two epochs which fill in the 'hiatus' which he formerly taught existed between the palæolithic and neolithic periods. They are the Tourassienne and the Compignyenne, referring to stations on the upper Garonne and the lower Seine. These bring us to the Robenhausienne, of Zurich, and so on.

The changes indicated are significant. I have before referred to those of similar character in the scheme of M. Salmon (see SCIENCE, p. 254). A leading question has been whether we can trace the oldest historic population of Europe in an uninterrupted culture-development back to the rough stone age (*pace*, Messrs. McGuire & Co.). This would seem now to be the case; and this carries with it the increased probability that the cradle of the Aryan or Indo-Germanic peoples was in western Europe.

THE ORIGIN OF LANGUAGE.

SOME years ago the Society of Anthropology of Paris passed a resolution to reject all papers written to show the origin of language; believing that all discusssions of that subject are fruitless and time-wasting. One has but to look over the historical sketch of the hypotheses advanced, written recently by Professor Steinthal under the title 'Die Ursprung der Sprache,' to become convinced how much nonsense has been poured out concerning this theme. Among others, he represents a full analysis of the theories of Ludwig Noiré, showing at once their acuteness and the vicious circle of reasoning, arriving nowhere, in which the author involves himself.

Nevertheless, Noiré has found admirers in this country, and the Open Court Publishing Company of Chicago has printed a pamphlet of 57 pages, 'On the Origin of Language and the Logos Theory, by Ludwig Noiré." It will be found an excellent presentation of his views for those who wish to learn them.

There is but one scientific method of approaching this problem, and that is not the *a priori* style adopted by most writers, but

* H. Fasbender in Ztschr. für Geburtshülfe und Gynäkologie, Vol. III., p. 286. Stuttgart, 1878.

by a patient analysis of the structure (morphology) of the languages of savage tribes. These reveal to us human speech on its lowest terms and it will be found something quite different from what we expected. Noiré's examples, on the contrary, are taken from the highly developed Aryan languages, and from their vocabulary, not from their morphology. Nearly all writers follow the same false trail, and consequently reach no results worth naming.

RECENT STUDIES IN CRANIOLOGY.

THE pathological effects of cretinism on the form of the skull have received inadequate attention. For this reason, a brief paper by Dr. Harrison Allen in the *New York Medical Journal*, for February 2, 1895, on the influence exerted by this condition on the shape of the nasal chambers and other cranial elements, is a welcome contribution.

The distinguished Roman craniologist, Professor Giuseppe Sergi, has added another to his many interesting studies of Mediterranean craniology by a paper of sixty pages in the *Bulletin* of the Medical Academy of Rome, 1894–1895, entitled 'Studi di Antropologia Laziale,' in which he discusses a number of skulls derived from cemeteries of ancient Latium. His conclusions are as we might expect, that the *populus romanus* of the Empire was decidedly mixed in blood and cranial types.

The island of Engano adjoins Sumatra, and little has been known about the physical type of its inhabitants, who, moreover, are rapidly dying out. For that reason, additional value is attached to a study of the skulls and bones brought from there by Dr. Modigliani, prepared by Dr. I. Danielli, and published in the 'Archivio per l' Antropologiae l' Etnologia,' Vol. XXIII. They appear to have belonged to a Malaysian people, with a dash of Negrito blood. A mixed population, at any rate, occupied the island, for the precise genealogy of which we must await further researches.

AFRICAN FOLK-LORE AND ETHNOGRAPHY.

IMPORTANT additions to the ethnography and folk-lore of the Bantu tribes have been recently made by Mr. Heli Chatelain, late U. S. commercial agent at Loanda, West Africa. First to be noticed is a volume of 315 pages, published by the American Folk-Lore Society, entitled 'Folk-Tales of Angola.' These are fifty tales, faithfully recorded from the lips of the native speakers, with the original Kimbundu text, a literal English translation and an instructive introduction and notes. It is an excellent and original study of these prominent tribes from the point of view of the folk-lorist.

An article broader in scope, by Mr. Chatelain, entitled 'African Races' is published in the *Journal of American Folk-Lore* for December last. In it the author undertakes to present the result of his observations and theorizing on African ethnography in general. The main point which he endeavors to prove is that there is no true racial or linguistic difference between the Bantu and the Sudanese negroes. The reasons for this, advanced in the note to page 207, are far from satisfactory. Mr. Chatelain, though a most competent linguist, clearly does not appreciate the value of linguistics in ethnography; and it is slightly preposterous to forbid any ethnologist to have an opinion about the affinities of a tribe unless he has lived with it. At that rate, that class of scientists would find their field limited indeed. There are many reasons, not discussed by Mr. Chatelain, for holding the Sudanese of pure type to be as different from the Bantus as, say, the Sibiric tribes of Asia are different from the Sinitic peoples; and that is all that has been maintained.

DR. EMIL SCHMIDT'S RECENT WORKS.

Dr. Emil Schmidt, of Leipzig, is favorably known to anthropologists by his many practical contributions to their science. His text-book on physical anthropology is the best manual extant. Quite lately I referred to his investigations into the pre-Columbian history of the United States (see Science, p. 256). These were a chapter of his large volume, 'Vorgeschichte Nordamerikas, im Gebiet der Vereinigten Staaten' (pp. 216, Braunschweig, 1894). This is divided into four parts, one on the very oldest relics of man in the area of the United States; the second on the prehistoric copper implements of North America; the third on the prehistoric Indians of North America east of the Rocky Mountains; and the fourth on those in the southwestern portions of the United States. These topics are treated with a thorough knowledge of the best authorities and a calm judgement. The book will, I hope, have a translation into English.

In another work, 'Reise nach Südindien' (pp. 314, Leipzig, 1894), Dr. Schmidt gives the results of his own observations and investigations into the native tribes of southern India. It is written in popular style, abundantly enriched with illustrations of the natives and of the scenery, and replete with valuable information.

THE ANCIENT ETHNOGRAPHY OF WESTERN ASIA.

There is no other portion of the globe of equal area the ancient ethnography of which is so interesting to the history of human culture as western Asia, in the land area included between the four seas, the Black, the Caspian, the Persian Gulf and the Mediterranean. This embraces Palestine, Mesopotamia and the upper Euphrates valley, eastern Asia Minor, Arménia, Mount Ararat and many other wondrous sites of old. Here lay the Garden of Eden, the holy cities and the earliest centers of civilization.

A most valuable contribution to the study of its earliest geography and ethnography, as understood by the ancient Egyptians and preserved in their writings, appeared a little over a year ago from the pen of Professor W. Max Müller, now of Philadelphia (Asien und Europa nach altegyptischen Denkmälern, pp. 403, Leipzig, 1893). It is very abundantly illustrated with copies of the ethnic types found on the Egyptian monuments and with texts in the hieroglyphic script of the Nilotic scribes. As the author is one of the most accomplished Egyptologists living, his translations of the hieroglyphs are peculiarly valuable to the ethnographer, since few students of that specialty have paid attention to ethnic descriptions. A map appended to the volume locates from Egyptian sources those troublesome people, the Hittites, this time, in Cappadocia, as well as the Mitanni, the Kilak, and other little known tribes. The numerous drawings of the faces, costumes, armors, etc., of these former inhabitants, as well as the profound linguistic analysis of texts, render this volume one of exceptional value.

D. G. Brinton.

University of Pennsylvania.

CORRESPONDENCE.

A CARD CATALOGUE OF SCIENTIFIC LITERATURE.

Editor of Science—*Dear Sir:* I presume that there is no doubt of the existence of considerable demand among workers in, and writers upon, various branches of science for an index catalogue of the books and papers relating to the subjects in which they are interested, and that an accurate card catalogue, each card to be promptly furnished as soon as the book or paper is published, will best meet this demand. It is also desired that each card should contain a brief summary of the contents of the article.

A large number of investigators and writers would be glad to have their work done for them by some automatic or mechanical means, as far as possible, up to a point just short of the conclusions or results. These, of course, they prefer to prepare and state themselves. Those who like literary research would be pleased to have coöperative laboratories established in which, for a moderate annual subscription, they could have any experiments made which they might suggest, the results to be reported to them for their use. Others would prefer to do the experimenting themselves, and have some one else tell them everything that other people have done and written about the matter. And if each party is able and willing to pay for the assistance he requires, and can find persons competent to give that assistance and willing to do the work merely for the pay offered, every one will agree that it is a good thing, and will furnish new channels of employment and remuneration for experts, for which channels the need is steadily increasing.

It is, however, not clear that the benefits to science and to humanity, which would result from a complete card index of science up to date and available for every one who would like to consult it, would be so great as to make it the duty of any existing scientific body or institution to incur the great expense of taking charge of the matter or to contribute largely to its support.

Physicians meet with some cases for which it is desirable that the food should be carefully minced and partially digested before it is given, and sometimes it is necessary to push this food far back on the tongue to make sure that it will be swallowed, or even to forcibly inject it, but in most cases this benefits no one but the patient.

There is a very considerable number of men now engaged in preparing abstracts and summaries of what is known in various branches of science, and publishing them as monographs, monthly reviews, year books, etc.; and in medicine, at all events, the supply of this kind of material is quite equal to the paying demand for it.

Moreover, it is not certain that the investigator who wishes to know everything that has been suggested with regard to the subject which he has under consideration will be much happier when he gets his card index up to date, if he has not made it himself. He will find references to articles by Smith, and Schmidt, and Smitovich; but where are the books containing these articles? Very probably, after a week's hunt and correspondence, he finds that there are one or two of them that are not in any library accessible to him, and then he is decidedly worse off than he would be if he did not know that they existed.

It is probable that such complete card catalogues with abstracts would be the means of adding largely to the bulk of scientific literature, as the Index Catalogue of the National Medical Library and the Index Medicus have done to the literature of medicine. The bibliography and the abstracts will be published over and over again in successive papers by different writers.

The expediency of having such card indexes prepared depends upon the cost, and upon whether the money could be used to better advantage in promoting the increase and diffusion of knowledge in other ways. I should suppose that $25,000 a year would be a moderate estimate for providing 25 copies of such a card index for all branches of science, and to bring the cost within this limit would require careful selection.

If each author were to make his own abstract, and every article thus abstracted is to be indexed, probably $50,000 a year would be required. Much might be done for the advancement of science with a fund of $25,000 per annum.

I do not wish to be understood as opposing the preparation and furnishing of an universal card index; the schemes proposed are beautiful in the glow and shimmer of their optimism—reminding one of Chimmie Fadden, "Up t' de limit an' strikin' er great pace t' git on de odder side of it," but they must be looked at from the practical business point of view by those who are to defray the cost, and who have, I feel sure, other important uses for their money and for the skilled brains required for such work, and more definite information is wanted with regard to the number of titles, etc., which must be indexed annually upon such a scheme before a wise decision can be made. For general Biology, Morphology, Physiology, Bacteriology and scientific Pathology, and other subjects of scientific importance connected with medicine, I think that about 10,000 cards a year would be sufficient if all second-hand matter and hash were carefully excluded.

Very truly yours,

J. S. BILLINGS.

WASHINGTON.

SCIENTIFIC LITERATURE.

The Great Ice Age and its Relation to the Antiquity of Man. By JAMES GEIKIE, LL. D., D. C. L., F. R. S., etc. Murchison Professor of Geology and Mineralogy in the University of Edinburgh, formerly of H. M. Geological Survey of Scotland. Third Edition, largely rewritten, with maps and illustrations. New York, D. Appleton & Company. 1895. 8vo., xxviii + 850.

Twenty-two years ago the first edition of this book appeared in England. The author then endeavored to give a systematic account of the Glacial Epoch, with special reference to its changes of climate. In so doing he entered first quite fully into the geological history of glacial and post-glacial Scotland, presenting many elementary matters, and taking more than half the book for this purpose. Afterwards he discussed the glacial phenomena as exhibited in England, Ireland, Scandinavia, Switzerland and North America. A newly acquired view with him related to the age of the paleolithic deposits of southern England—all of which he referred to inter-glacial and pre-glacial times. It was this book that first called the attention of many geologists to the doctrine of several periods of cold in the ice age separated by as many times of milder conditions. Like the early doctrine of Agassiz and Buckland that the drift phenomena were to be explained by the agency of glaciers, so this theory of a series of cold and warm periods has been vigorously contested by geologists, but bids fair to be as generally accepted as the former. In 1877 a second edition of the book appeared. The author remarks in its preface that great additions to our knowlege of the facts had been made, above those first presented, all of which strengthened his argument that the epoch was not one continuous age of ice, but consisted of a series of alternate cold and warm or genial periods; while the ancient cave-deposits cannot be assigned to a later date than the last genial interval of the ice age, and some of them were probably still older. Among the more important alterations he notes a change in the use of the terms *till* and *boulder clay*. Instead of calling one purely glacial and the other partly marine, both are referred more or or less directly to the grinding action of glaciers, and are strictly synonymous terms. Likewise he modifies his view of the *kames;* none of them are now regarded as of marine origin. There has been no great submergence of Scotland since the close of the glacial epoch, and thus the Scotch deposits are brought into much closer relationship with those of England. In the interim he made many personal studies of the English phenomena until able to say positively that after the deposition of the ossiferous gravels

and *Cyrena* beds, a great ice-sheet stretched south as far as the valley of the Humber, thus proving the existence of a later ice incursion. In the first edition the term *kames* was not differentiated from *esker* and *åsar*, and all of them were believed to have been of marine origin; now he separates the kames from the esker and åsar and adopts Hummel's river theory of the origin of the latter, besides disowning the necessity of any marine agency in the formation of the kames. The accounts of the glacial phenomena in Europe and America are given with greater fullness in the second edition. The second edition attained a bulk of xxx + 624 pages and a larger size of page than the first, which had xxv + 524 pages.

The third and present edition shows a similar increase in size above its predecessor, but not so great a modification in the fundamental principles. About one-fourth of the subject-matter, or that relating chiefly to Alpine, Arctic and Scottish parts has been revised; but the other three-fourths have been entirely rewritten. The glacial and interglacial deposits of the continent are treated with a fullness that was impossible before. Many sections of it have been visited personally and the results of others verified. Aid has been received from a multitude of friendly fellow laborers. Necessarily because of the astonishing increase in the literature of Surface Geology, many important contributions are unnoticed. He does not profess to write the history of the rise and progress of glacial geology, but simply to sketch its present position. Nowhere, he says, has glacial geology been more actively prosecuted in recent years than in America. While he has endeavored to keep abreast of this, he preferred to have a summary of the American evidence prepared by a recognized authority; and hence called upon Professor T. C. Chamberlin, of Chicago, to furnish him with a digest of this material; which is of great service to every-one, since we have been awaiting almost with impatience the announcement of some general statements here first presented to the public. Professor Geikie also expresses his great gratification that his conclusions should essentially agree with those of Professor Penck, of Vienna, in respect to the glacial phenomena of the Alpine lands, the Pyrenees and Auvergne.

The following is a summary of the glacial succession in Europe as determined by Professor Geikie from a consideration of all the facts:

1. *Older Pliocene.*—Before the advent of the cold the sea occupied considerable tracts in the east and south of England, in Belgium, Holland, northern and western France and the coast lands of the Mediterranean, and boreal forms are just beginning to make their appearance.

2. *Newer Pliocene—First Glacial Epoch.*—The Weybourn crag and Chillesford clay of England with their pronounced arctic fauna represent a part of the evidence for this time of cold; also the bottom moraine near the Baltic sea, in southern Sweden, where the movement was from the southeast to the northwest. Arctic animal remains have also been detected in East Prussia at a similar horizon. Hence it is suggested that a gigantic glacier occupied the basin of the Baltic sea, and the mountainous parts of Scandinavia and the British Isles were snow clad. In the Alps the snow line was depressed for 4,000 feet or so below its present level, and all the great mountain valleys were filled with glaciers which left behind terminal moraines at the foot of the chain. In central France very considerable glaciers descended from the great volcanic cones of Auvergne and Cantal.

3. *First Interglacial Epoch. Latest Pliocene. Forest Bed of Cromer.*—The arctic fauna retreated from the North Sea, and dry land occupied the southern part of this sea up to the latitude of Norfolk. The river

Rhine flowed across this land. A temperate flora, much like that now existing in England, prevailed; and among the land animals were elephants, hippopotami, rhinoceroses, horses, bison, boar, deer, machærodus, hyæna, wolves, glutton, bear, beaver, etc. In other parts of Europe similar genial conditions prevailed. A luxuriant deciduous flora occupied the valleys of the Alps, attaining heights greater than the present limits of the same vegetation. Elephants existed with the flora in northern Italy. From the amount of river-erosion effected during this epoch it would appear that the stage was one of long duration.

4. *Second or Maximum Glacial Epoch.*—The mountains of Scandinavia seem to have been the center of dispersion of the ice at this time, and the glaciers extended easterly so as to become confluent with the Ural system in western Siberia, southwesterly into the basin of the Volga, southerly into the basin of the Dnieper, Poland, Saxony, Belgium, southwesterly to the British Islands, excepting a small part of southern England, and to the westward 600 feet below the present surface of the Atlantic ocean, from off Ireland to the Arctic sea. Both the Baltic and North seas were covered by ice, and erratics from the Scandinavian hills were strewn more or less over this entire area. They were also transported from lower to higher levels in the British islands, to a height of 3500 feet in Scotland, and the highest peaks may have projected through the ice as *Nunatakker*, like the bare spots thus designated in Greenland. This area is rudely elliptical in shape, 2700 miles long and 1600 miles wide. In Switzerland the Alpine glaciers reached their greatest extension, the snow line extending 4700 feet lower than it is at present, the ice being 4000 feet thick in the low grounds, and immense blocks of stone were carried across to the Jura Mountains to an elevation of 3099 feet above Lake Geneva. In connection with the presence of this ice, Arctic-Alpine plants and animals occupied the lowgrounds of Europe, extending even to the Mediterranean. This epoch constituted the beginning of the pleistocene or quaternary period.

5. *Second Interglacial Epoch.*—The return of the temperate flora and fauna in north Germany and central Russia is suggestive of a milder and less extreme climate than is now experienced in those regions. Britain must have been connected with the continent and Italy with North Africa. The rivers of this epoch eroded their valleys to great depths.

6. *Third Glacial Epoch.*—An extensive ice-sheet overwhelmed most of the British Islands and much of the continent. The northwestern limits are much the same in the edges of the Atlantic and Arctic oceans, but to the east it extended about a hundred miles beyond St. Petersburg, and just reached Berlin to the south. From the Alps glaciers descended to the low grounds, dropping conspicuous moraines, which extend in curving lines between the highly denuded moraines of the earlier epochs, and the associated extensive fluvio-glacial gravels.

7. *Third Interglacial Epoch.*—The youngest interglacial beds of the Baltic coastlands belong here, with both arctic and temperate marine faunas—as the mammoth, wooly rhinoceros, hare, urus and Irish deer. It is probable that a considerable portion of the old alluvial deposits of Britain and Ireland, hitherto classed as post-glacial, belong here.

8. *Fourth Glacial Epoch.*—The ice-sheets of the British Islands are now local and entirely separate from the Scandinavian mass. In Scotland the snow line did not exceed 1600 feet in elevation above the sea; the land was 100 feet higher than now, and an arctic marine fauna occupied the coasts. The Scandinavian peninsula supported an ice-sheet of more importance,

which discharged icebergs at the mouths of fiords in western Norway. Finland was overwhelmed, and the Baltic basin was occupied by a great ice stream, which invaded north Germany and Denmark. As the ice melted, a wide area in Scandinavia was submerged in a cold sea communicating with the Baltic. In the Alps the snow line was 300 feet lower than now.

9. *Fourth Interglacial Epoch.*—The British Islands were connected with the continent. Deciduous trees spread far north into regions now bereft of them. The Baltic sea became converted into a great lake; Denmark and Sweden were united; the Rhine flowed quite near England and Scotland, over the upraised bed of the North Sea, meeting the main ocean above Bergen; the Seine flowed through the English channel beyond Brest, and there was a large river flowing over the bed of the Irish Sea, having the Severn for a tributary, and meeting the ocean quite near the mouth of the Seine, and there was a land connection between the continent, Great Britain, Iceland and Greenland. When the salt water finally returned, the fauna was more temperate than it is at present. This epoch is not yet recognized in the Alps.

10. *Fifth Glacial Epoch.*—In Scotland the snow line reached an average height of 2,500 feet, the shore line being fifty feet lower than it is now. Occasionally glaciers discharged bergs into the sea on the northwest coast of Scotland. Most of the corrie rock-basins of the British Islands were excavated in this epoch, each one marking the presence of a distinct glacier. In the Alps there were advances of the glaciers giving rise to terminal moraines, the snow line reaching a depression of 1,600 feet below the present limit.

11. *Fifth Interglacial Epoch.*—The upper 'buried forests' of northwest Europe show that this epoch was characterized by drier conditions and a remarkable recrudescence of forest growth. It is uncertain whether Britain was connected with the continent.

12. *Sixth Glacial Epoch.*—This is indicated by the latest raised beaches of Scotland, indicating twenty or thirty feet of depression. The snow line stood at an elevation of 3,500 feet, and thus a few small glaciers could exist in the loftiest highlands. In the western Alps there were some high level moraines.

13. *The Present.*—The sea has retreated to its present level, drier conditions prevail and permanent snow fields have disappeared from most of the regions in northern Europe once so completely submerged by glacial ice. The term post-glacial properly describes only the present epoch.

Professor Geikie devotes three chapters to a discussion of the presence of man in the Pleistocene. His bones and implements are found chiefly in the extra-glacial regions, associated with the remains of both extinct and living mammalia, such as have been mentioned as occurring in several of the interglacial epochs. Man would naturally migrate towards the glaciers as they receded, and retreat southerly as they advanced. The large animals would have done the same; hence a perfectly satisfactory correlation of the several terranes in the glaciated and extra-glacial regions is of difficult attainment. Our author concludes that Paleolithic man existed abundantly in the second interglacial epoch in company with the *elephas antiquus* and hippopotamus. Some of the caves occupied by him appear to have been abandoned before the third glacial epoch reached its climax, because they are sealed up by the moraines of that stage. During this epoch Paleolithic man seems to have retired to southern France, and, if negative evidence is of value, he never revisited northwestern Europe.

American geologists will be more than pleased with the sketch of the glacial phenomena of North America by Prof. Cham-

berlin. The facts correspond in a general way with those described by Professor Geikie in Europe. The attempt is made to group the stages of glaciation and deglaciation both on a two-fold and a three-fold basis, without deciding which is the more acceptable. The foundation of the grouping is what is called 'imbrication' of the till, or the superposition of the later or more northern sheets upon the earlier or more southern ones. The oldest is the *Kansan*, next the *East Iowan*, and thirdly the *East Wisconsin* stage of glaciation, followed by six, seven or more terminal moraines. Professor Geikie says that these general conclusions harmonize with the results obtained in Europe, and without hesitation he correlates the Kansan stage with his second glacial epoch, the time of maximum glaciation, after which the ice sheets declined in importance.

Granting the correctness of the correspondence of the Kansan stage to the second or maximum glacial epoch of Geikie, American geologists can easily complete the correlation. The Lafayette or Orange sand deposit will correspond to the first or Pliocene phase of the glacial epoch. This reference will be satisfactory to those who believe in elevation as a prime cause of refrigeration, as it is generally conceded that the late Pliocene was a time of continental uplift. It should be satisfactory to the advocates of the unity or continuity of the ice-age, because there was just one period of maximum intensity or culmination of refrigeration—the Kansan phase. It was preceded by the Pliocene-Lafayette flood, and followed by the gradually less intense Iowan, Wisconsin and later phases. It will, however, enlarge our conceptions of the magnitude of the ice age in geological history; for we cannot deny that the remotest centers of dispersion have been active from the beginning of refrigeration. The latest geological epochs are fundamentally glacial for the countries above forty degrees of latitude on both sides of the equator; ice-action characterizes the time. The writer has hitherto been esteemed an advocate of unity; but he has repeatedly insisted that the several margins of glacial accumulation indicate just so many phases of more intense glaciation, and that they are to be our criteria of classification. He is satisfied that they can be interpreted to correspond with the several glacial and interglacial epochs established by Professor Geikie.

It remains only to notice the chapter upon the cause of the climatic and geographical changes of the glacial period. The ratio of precipitation was the same as now prevails. Snow fields gathered most abundantly in those regions which in our day enjoy the largest rainfall. What are now dry regions were formerly regions of limited snowfall. But the amount of precipitation was greater, snow in the north and rain in the south. Arctic currents prevailed near the equatorial in the cold epochs, but the reverse was true in the interglacial phases. The land seems to have been elevated at the commencement of every cold epoch and depressed at its close, submergence having been more characteristic of the glacial than of the interglacial phase. The fiord valleys were mostly excavated before glacial times. The Scandinavian flora migrated to Greenland after the close of the fourth glacial epoch, when the land was continuous between the continents. There are considerations favorable to the view that the accumulations of ice in the several glacial epochs produced depressions, not excluding epeirogenic warpings of the crust. The cause of the remarkable connection between glaciation and depression is still an unsolved problem. All the proposed astronomical causes of refrigeration are rejected as untenable, except that of Dr Croll, supplemented by Ball, who believed the

climatic changes of the glacial period resulted from the combined influence of precession of the equinoxes and secular changes in the eccentricity of the earth's orbit. In favor of this view, the mean temperature of the globe was lowered, and the ratio of the precipitation increased; the dominant set of the currents in the Atlantic was from north to south in the colder terms. In the interglacial climates the summers were cooler and the winters warmer, while the Atlantic currents flowed northerly. The maximum glaciation came early, succeeded by cold epochs of diminishing severity. Glacial epochs in the northern hemisphere were necessarily contemporaneous with interglacial conditions in the southern hemisphere. Hence the astronomical theory would appear to offer the best solution of the glacial puzzle; while it is conceded that this answer is not completely satisfactory. C. H. HITCHCOCK.

Biological Lectures and Addresses, by ARTHUR MILNES MARSHALL. Macmillan & Co., New York. Price $2.25.

Lectures on the Darwinian Theory, by ARTHUR MILNES MARSHALL. Macmillan & Co., New York. Price $2.25.

It was a curious coincidence by which accidents in mountain climbing deprived English science of two of its prominent biologists, and two who were at the same time personal friends. Prof. F. M. Balfour, as every one remembers, lost his life in a journey in the Alps, and Prof. Arthur Milnes Marshall, upon the last day of 1893, in a somewhat similar manner, met his death in mountain climbing. Prof. Balfour and Prof. Marshall were personal friends and naturally worked upon kindred subjects, although their work was very unlike. Prof. Marshall was still a young man, only about forty years of age. Early in life he entered upon studies looking toward the profession of medicine, but in 1879 gladly accepted the chair of Zoölogy in Owens College, and continued to occupy the chair until his death.

His additions to the literature of science have been of two general types. There are first a series of papers embodying the results of original research. These, because of his intimate association with Balfour, were at first of an embryological nature, while some of the later ones were more distinctly anatomical. His chief contributions to science of this sort were upon the *Segmental value of Cranial Nerves*, the *Pennatulida of the Porcupine and Triton Expeditions*, and upon *The Nervous System of the Crinoids.* The second class of his papers were more distinctly characteristic of his special powers. They were of a more general character and included a text-book on *The Frog*, on *Practical Zoölogy*, and a more recent work upon *Vertebrate Embryology.* In addition, we have in the recent posthumous volumes a large number of lectures and addresses given in various places before various societies.

Above all things, Professor Marshall was a teacher. It was in this direction that his powers showed at their best. He had the happy way of putting subjects so that they were intelligible to his audiences, and had the somewhat unusual power of putting himself in the position of his audiences, in such a way that he could understand how and what was needed in his teaching to render his subjects clear. His lectures were always abundantly illustrated both by drawings, and especially by homely though terse illustrations. His illustrations for rendering scientific facts intelligible were drawn sometimes from the most surprising sources, and altogether rendered his addresses and his class lectures of the very highest character in the way of scientific teaching. Since his death Macmillan & Co. have published his collected lectures and addresses in the two volumes which are the subject of this notice. The first series consists of miscellaneous addresses given by him at various intervals

between 1879 and the time of his death, and before a number of debating societies and scientific organizations, ending with his presidential address before the British Association in 1890. These addresses are all designed for a somewhat popular audience, and treat of different scientific subjects in a clear, entertaining manner. Among the most interesting of them the lectures that will, perhaps, first commend themselves to the reader are those on Fresh Water Animals, on Inheritance, on Shapes and Sizes of Animals, and the one upon the Recapitulate Theory. Professor Marshall possessed in a wonderful degree the power of seizing hold of the salient points of abstract scientific subjects and isolating them from the cumbersome mass of details with which they are associated in ordinary scientific discussions. The result is that in a few pages the reader obtains a clearer conception of the salient points in a subject like embryology by reading the last of the essays in this volume than he might obtain from the careful perusal of many lengthy books upon the subject. Details, of course, are left out, but the salient and interesting points which embryology teaches and attempts to teach are presented with wonderful clearness. The addresses are, in short, popular science of the highest type, and one does not wonder after reading them that Professor Marshall was one of the most popular lecturers in the University Extension courses.

Every teacher is aware how difficult it is to send a young student to literature that will give him a clear, succinct account of evolution. Scientific discussions of one and another phase of the subject are abundant, but usually they are beyond the comprehension of the ordinary reader. Many a student having been recommended to read Darwin's Origin of Species reads the book with an utter failure to comprehend Darwinism. Nor is this the fault of the student. Even the better class of thinking students are so handicapped by the abundance of material in that Darwinian classic that the thread of the argument is lost, and they are just as likely to confuse Darwin's views with those of Lamarck as they are to understand Darwinism. Few students who are beginning the study of modern biology will have any proper appreciation of Darwinism from the study of the Origin of Species, or, indeed, from the study of most of the scientific writings on evolution, unless the essential facts are presented to them in some form of introduction. For this reason the series of lectures on the Darwinian theory by Professor Marshall are especially valuable. These lectures are not encumbered with numerous details, but seize hold of the thread of the Darwinian argument and present it before the reader in such a way that he cannot fail to understand evolution and Darwinism after having finished such a volume. This series of essays will, therefore, be perhaps the best literature to which a student can be sent at the present time to enable him to understand what evolution was before Darwin, what Darwin added, and what have been the subsequent modifications and criticisms of Darwin's theory. Professor Marshall writes as a partisan and thorough believer in Darwin, and presents his facts in such a way that his readers cannot fail to recognize the full force of the Darwinian argument. Indeed, he naturally exaggerates the force of many arguments, frequently begs the very question of the issue, and the essays are by no means calculated to be critical discussions. The lectures cannot be considered as a fair presentation of the Darwinian theory. The innocent reader will conclude that the argument upon Darwinism is all on one side, that every essential feature of it is abundantly demonstrated and all criticisms are refuted. But, in spite of this fault, which comes naturally from one who is attempting to teach a theory in which he so fully believes,

the outline of the Darwinian theory is an exceptionally good one. Certain it is that nothing in our literature at the present time will give such a terse, clear presentation of the Darwinian hypothesis with the arguments in its favor, and of the additions which have been made to this hypothesis subsequent to the writings of Darwin himself.

These two books are, then, designed for popular reading. They are perhaps as good an illustration of the especial character of Prof. Marshall's power in teaching as could be found. They are valuable additions to that class of books in which the English language is beginning to abound, viz., popular scientific writings that actually *teach science*.

H. W. CONN.

WESLEYAN UNIVERSITY.

Elements of Astronomy.—By GEORGE W. PARKER, of Trinity College, Dublin. Longmans, Green & Co., London and New York. 8vo., 236 pages. $1.75.

The book is designed as a connecting link between the elementary school-astronomies and the higher treatises used as text-books in the universities. It treats the subject almost exclusively from the geometrical point of view, breaking up the matter into propositions, corollaries and problems, arranged in an order which is probably logical enough in its mathematical sequence, but strikes one as rather peculiar. The book will be found useful by teachers who have 'examination papers' to draw up, since it presents a large number of them, as well as numerous 'exercises' and problems well suited to test a student's understanding of the subject-matter.

What the book professes to do is in the main very well done. The statements and definitions are intelligible and correct, and the reasoning is generally clear and logical. The writer's description of the instruments and methods of practical astronomy make it evident, however, that he has had very little actual experience in that sort of work. It reads rather strangely, for instance, to be told that the way to find the value of a micrometer-screw revolution is to 'note how many turns correspond to the sun's diameter.'

Regarded as an elementary presentation of 'Astronomy' taken as a whole, the book must be pronounced extremely one-sided and defective. Astrophysics is most inadequately dealt with; the whole subject or spectroscopy is dismissed with six pages and a single old diagram of the dispersion of light by a prism; and all physical matters relating to sun, planets, comets, stars and nebulæ are treated on the same general scale.

C. A. Y.

Qualitative Chemical Analysis of Inorganic Substances—As practiced in Georgetown College, D. C. American Book Co., New York. 1894.

Rev. H. T. B. Tarr, S. J., formerly professor of chemistry in Georgetown College, prepared a series of tables for analytical purposes, which have been wholly recast and incorporared into the work now before us. The present editor, Rev. T. W. Fox, S. J., speaks of the book as being 'useful in a course such as is given at Georgetown and in similar institutions throughout the country.'

The 'grouping of the bases' is that generally adopted by writers on qualitative analysis the world over. We believe, however, that it would have been wiser and better for the student had the author divided his third group, consisting of the metals precipitated by ammonium sulphide from neutral or alkaline solutions, into two groups. But this is merely a matter of opinion.

We observe that the properties of the metals are first studied, after which the author draws up a table for the analysis of

a mixture of metals, constituting a particular group, accompanied by explanatory notes. This order is preserved throughout the book, which consists of sixty-one pages. We trust that the author and the reader will pardon us when we declare that we think such tabular schemes, so early in the course of analysis, are apt to make the student a mere machine—precisely what the author, in his introductory remarks, announces that he wishes to avoid, for he writes, "A mere mechanical acquaintance with a working scheme for separating * * * * * is at best but a questionable accomplishment," etc. And, for some unaccountable reason—perhaps from natural, human depravity or perversity—the great majority of students, beginning analysis, do wed themselves to such a table or scheme and cling to it, despite the rough handling they may receive from an earnest and intelligent quiz-master. But we are rambling. On returning to our subject we discover in it no new methods of separation, no new characteristic test or tests for the various elements; the landmarks in these directions remain unchanged. This is pardonable, seeing that "no pretense is made to originality, either in matter or in method."

Part II. considers the 'acid analysis' and commences with excellent advice for the student, who must now, more than ever, apply what knowledge he may have acquired in regard to the metals and their various combinations with acids.

Brief chapters on 'preliminary examinations,' the solution of solid substances, a table of solubilities, and an appendix, dealing with the preparation of the ordinary reagents, conclude the book.

The little volume is well written and nicely printed. Its chief merit seems to be that it presents its author's particular method of instructing students in this most important branch of chemistry, upon which many others have likewise prepared similar brochures. The same kindly welcome given them must be accorded this latest arrival. Each does some good, and together they will doubtless do great good.

EDGAR F. SMITH.

A Course of Elementary Practical Bacteriology, Including Bacteriological Analyses and Chemistry. By A. A. KANTHACK AND I. H. DRYSDALE. XXII. 181 pp. Sm .8°. Macmillan & Co., London and New York. 1895. Price $1.10.

This is a laboratory hand-book which will be interestiug to all practical workers in bacteriology, since it gives the details of methods used in the Laboratory of St. Bartholomew's Hospital in London. Some of these methods are not so useful as those now employed in American Laboratories; as, for example, that given for the collection and sterilisation of blood serum, while some are probably more rapid and convenient. As the authors remark, every laboratory has its own ways and means, its 'short cuts' and 'tips,' which are not always published, and it is necessay to work for a little while in the laboratory to become acquainted with them. The descriptions given are simple and straightforward, and well calculated to meet the wants of students. The plan and order of the several lessons will be found interesting by teachers of the subject. The lessons in Bacteriological Chemistry contain good matter not usually found in a manual of this kind.

NOTES AND NEWS.

TYPHOID INFECTION OF OYSTERS.

THE *Medical News* of March 23, contains a paper by C. I. Foote, giving the results of experiments with oysters, and with the water in which they grow, to determine the possibilities of their becoming infected with the bacillus of typhoid. He found that this bacillus will live in brackish water, taken from just above oyster beds, for at

least eight days, even in very cold weather. In apparently normal and healthy oysters and in their juice he found bacteria of various kinds; the number of which that will grow in gelatin ranging from 240 to 1680 per c.c. The number found in the water over the oysters was 9520 per c.c., indicating that the water is purified by being taken into the shell. He inoculated a number of oysters with typhoid bacilli by injecting a culture of these organisms between the edges of the shells. The results indicate that the bacilli can live in the oyster for from one to two weeks, but it is doubtful whether they multiply there. But the oysters were cleaned before inoculation, and, after the operation, were apparently not placed in water, but simply kept in a cool room. The research would have given much more definite and conclusive results if the oysters had been placed in brackish water, and then the typhoid bacilli added to this water, so that they might have been taken in and disposed of in the natural way.

ARGON.

ACCORDING to the *London Times*, M. Berthelot has supplied the first information concerning the chemical properties of argon. In experimenting with a small quantity of that substance, furnished by Professor Ramsay, he has found that under the influence of the silent electric discharge it combines with various organic compounds, and notably with benzene. It is decidedly interesting to discover that argon, which is supposed to be totally inert, and has been vainly subjected to all the most potent agencies at the command of the chemist, is all the time capable of forming a variety of combinations under conditions which always exist in the atmosphere. Great interest also attaches to M. Berthelot's communication in connection with the obscurity which hangs over the chemical nature and relationships of the new substance. For he pointed out years ago that nitrogen combines, under the influence of the silent discharge, with hydrocarbons like benzene, with carbohydrates, such as go to build up the tissues of plants, and even with tertiary products, such as ether.

GENERAL.

DR. WILLIAM S. W. RUSCHENBERGER, President of the Philadelphia Academy of Science from 1869 to 1881, died on March 24th, at the age of eighty-seven years.

DR. JOHN A. RYDER, Professor of Embryology in the University of Pennsylvania, died on March 26th.

THE Library Building of Harvard University will be altered during the present summer in such a manner that the space for books will be greatly enlarged.

THE North Dakota State University must be closed until the next session of the Legislature, in January, 1897, owing to the fact that the appropriation has been reduced from $63,000 to $15,000.

THE British Association will meet at Liverpool in 1896. The Council have resolved to nominate Sir Joseph Lister for President.

T. G. CROWELL & Co. announce 'Forests and Forestry' by the Hon. B. E. Fernow, of the Department of Agriculture, and 'Marriage and the Family,' by Professor George E. Howard, of Stanford University.

THE sixty-third annual meeting of the British Medical Association will be held in London, July 30th to August 2d, 1895.

THE next meeting of the American Microscopical Society will be held at Cornell University, Ithaca, New York, on August 21, 22 and 23, 1895.

DR. K. SCHMIDT has been made Professor of Physics in the University of Halle.

THE two final volumes of the report on the scientific results of the voyage of H. M. S. Challenger, prepared under the direction

of Dr. John Murray, have now been published by Eyre & Spottiswoode, London. The completed work fills 50 large quarto volumes containing about 29,500 pages and illustrated by over 3,000 plates. These two concluding volumes are mainly occupied by a general summary of the scientific results of the voyage.

DR. A. R. FORSYTH, of Trinity College, has been elected to the Sadlerian Professorship of Mathematics in the University of Cambridge, succeeding the late Professor Cayley.

ACCORDING to the *American Geologist*, efforts are being made looking towards a geological survey of the State of Maine.

DR. JOHN P. LOTSY, now Associate in Botany at Johns Hopkins University, has accepted the Directorship of the Botanical Gardens on the Island of Java.

THE Lake Superior Mining Institute made an excursion on March 6th, 7th and 8th, from Duluth to the Mesabi iron range. The mines were visited and in the evenings meetings were held, at which papers were presented by Dr. L. L. Hubbard, Dr. U. S. Grant, Mr. F. W. Denton, Mr. F. F. Sharpless and Mr. E. F. Brown.

THE tenth annual meeting of the American Association for the Advancement of Physical Education will be held at the Teachers' College, New York, on April 25th, 26th and 27th.

THE Journal of Mental Science gives, in the last number, a retrospect of Normal Psychology, prepared by Mr. Havelock Ellis, and proposes to give regular summaries of the progress of psychology.

THE Chemical Society has conferred its Faraday medal upon Lord Rayleigh in recognition of the investigation which has led to the discovery of Argon. Dumas, Canizzaro, Wurtz, Helmholtz, and Mendeléeff have been the previous recipients of the medal.

REV. HERBERT A. JAMES, principal of Cheltenham College, has been elected head master of Rugby, succeeding the Rev. Dr. Percival.

THE Woods Holl Biological Lectures for 1894, in the press of Ginn & Co., include : I. *Life from a Physical Standpoint.*—A. E. DOLBEAR. II. *A Dynamical Hypothesis of Inheritance.*—JOHN A. RYDER. III. *On the Limits of Divisibility of Living Matter.*—JACQUES LOEB. IV. *The Differentiation of Species on the Gálapagos Islands and the Origin of the Group.*—G. BAUR. V. *Search for the Unknown Factors of Evolution.*—H. F. OSBORN. VI. *The Embryological Criterion of Homology.*—E. B. WILSON. VII. *Cell-Division and Development.*—J. P. MCMURRICH. VIII. *The Problems, Methods and Scope of Developmental Mechanics.*—W. M. WHEELER (Roux's). IX. *The Organization of Botanical Museums for Schools, Colleges and Universities.*—J. M. MACFARLANE. X. *The Centrosome.*—S. WATASÉ. XI. *Evolution and Epigenesis.*—C. O. WHITMAN. XII. *Bonnet's Theory of Evolution.*—C. O. WHITMAN. XIII. *Bonnet on Palingenesis and Germs.*—C. O. WHITMAN.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON, MARCH 23.

MR. CHARLES T. SIMPSON read a paper on the 'Respective Values of the Shell and Soft Parts in Naiad Classification.' Mr. Simpson deprecated the fashion of many conchologists of late in basing classification wholly on the soft parts and stated that his studies of the Naiads, or fresh water mussels, go to show that among them, at least, he has found the characters of the soft parts of the animal more variable and less reliable for the purposes of classification than those of the shell. That, while in some cases the soft parts give us the key to true affinities, in others they are worthless, and we must rely on the shell for a knowl-

edge of relationships. Numerous cases were cited showing such variation. In *Unio novi-eboraci* the branchiæ are sometimes free only a short distance on the posterior part of the abdominal sac; in other cases they are united the whole length, and the same is found to be true to a great extent in *U. multiplicatus*. In that species and some others not closely related the embryos are found in all four leaves of the branchiæ, but in all other North American forms they only occupy the outer leaves.

The statement was made that the dissection of a single animal of a widely distributed and variable species will probably not give any more knowledge of all its characters than the examination of a single shell, *Castalia*, *Castalina* and *Glabaris*, South American Naiads, may either have no siphons at all, or have them perfectly developed, and this variation occurs in the same species. The families *Unionidæ* and *Mutilidæ* were founded on the absence or presence of this character. In a new arrangement of the Naiads v. Ihering has based the family *Unionidæ* on the fact that the embryo is a *glochidium*, in which the soft parts are enclosed in a bivalve shell, and the *Mutilidæ* was established on the fact that the embryo is a *lasidium*, divided into three parts, the middle one only being protected by a single shell.

Basing a classification on these characters it will be found that *the genera of the unionidæ have invariably heterodont teeth, or vestiges of them, while in the mutilidæ the arrangement is essentially taxadont.*

It is claimed that similar circumstances of environment may produce like characters of unrelated forms; the *Mycetopus* of South America and *Solenaia* of China are burrowers, and though belonging to different families closely resemble each other in the elongated shell and greatly developed foot, and have both been placed in one genus on this account. *Anodonta angulata* burrows in rapid streams and differs greatly in appearance from *A. dejecta*, which is closely related but lives in stagnant water. The two were shown to have affinities by connecting forms.

Dr. Stiles spoke* 'On the Presence of Adult Cestodes in Hogs.' He called attention to the remarkable fact that no adult tapeworms were described as regular inhabitants of *Sus*, and discussed the cases recently mentioned by Cholochowsky in Russia and two cases which had recently been reported to him from Iowa. One of the Iowa cases was certainly a case of chance parasitism in this host, and although there are no satisfactory data upon which to base an opinion concerning the other cases, he thought helminthologists in general would not admit the forms mentioned to the lists of the parasites of hogs.

Mr. Coville laid before the society a copy of the newly published list of ferns and flowering plants of the northeastern United States, prepared by a committee of the Botanical Club, A. A. A. S., in accordance with the nomenclature rules adopted by the Club, and gave a brief history of the recent nomenclature reform in botany. He pointed out the fact that in a recent criticism of the List by Dr. B. L. Robinson, who represents those still favoring the old system, only a single specific point of vital principle in the new system was really discussed, the other items of criticism referring to details which do not involve the principles themselves. Mr. Coville pointed out that in view of the success of the new system as already tried by several of our leading botanical institutions and as tested for many years past in other branches of biological science, together with the prevailing dissatisfaction regarding the old system among working botanists, the new code gives every

*Notes on Parasites, 34; Centralbl. f. Bakt., u. Par. 1895.

promise of satisfactorily solving the nomenclature problem.

Professor Joseph F. James made some remarks on 'Daimonelix and Allied Fossil.' He gave an account of the large fossil 'cork screws' described by Professor Barbour from the Bad-Lands of northwestern Nebraska, calling attention to their peculiar features. He noted the fact that while they had heretofore been considered as unique and without resemblance to other fossils, that in reality several other similar forms had been described. One of these was figured by Heer in 1865 in 'Die Urwelt der Schweiz,' under the name of 'screw-stones,' which presents all the characters of *Daimonelix* as figured by Barbour. In 1863 Professor James Hall described *Spirophyton* and gave a restoration of *S. typum*. In a view of one of the whorls there is a great correspondence between it and a figure of the same character given by Barbour. In 1883 Professor Newberry described *Spiraxis*, also a genus of screw-like fossils which presents features similar to *Daimonelix*. Heer's fossil occurs in the Miocene of Switzerland, while *Spirophyton* and *Spiraxis* occur in the Chemung of New York and Pennsylvania. The wide distribution of the forms is interesting as showing that *Daimonelix* is not an 'accident' as hinted by some. Whether it is a plant or not must be decided in the future, although there is a strong presumption that such is the case.

FREDERIC A. LUCAS,
Secretary.

SCIENTIFIC JOURNALS.

AMERICAN CHEMICAL JOURNAL, APRIL.

Argon, A New Constituent of the Atmosphere: LORD RAYLEIGH and WILLIAM RAMSAY.

On the Spectra of Argon: WILLIAM CROOKES.

The Liquefaction and Solidification of Argon: K. OLSZEWSKI.

On the Atomic Weight of Oxygen. Synthesis of Weighed Quantities of Water from Weighed Quantities of Hydrogen and of Oxygen: EDWARD W. MORLEY.

On the Chloronitrides of Phosphorus: H. N. STOKES.

On the Saponification of the Ethers of the Sulphonic Acids by Alcohols: J. H. KASTLE and PAUL MURRILL.

Contributions from the Chemical Laboratory of Harvard College. LXXXVI. On the Cupriammonium Double Salts: THEODORE WILLIAM RICHARDS and GEORGE OENSLAGER.

Basswood-oil: F. G. WIECHMANN.

Note.

AMERICAN JOURNAL OF SCIENCE, APRIL.

Niagara and the Great Lakes: F. B. TAYLOR.

Disturbances in the Direction of the Plumb-line in the Hawaiian Islands: E. D. PRESTON.

Glacial Lake St. Lawrence of Professor Warren Upham: R. CHALMERS.

Argon, a New Constituent of the Atmosphere: LORD RAYLEIGH and W. RAMSAY.

Velocity of Electric Waves: J. TROWBRIDGE and W. DUANE.

Epochs and Stages of the Glacial Period: W. UPHAM.

Structure and Appendages of Trinucleus: C. E. BEECHER.

Scientific Intelligence; Chemistry and Physics; Geology and Mineralogy; Botany; Miscellaneous Scientific Intelligence; Obituary.

AMERICAN GEOLOGIST, APRIL.

The Stratigraphy of Northwestern Louisiana: T. WAYLAND VAUGHAN.

The Paleontologic Base of the Taconic or Lower Cambrian: N. H. WINCHELL.

The Missouri Lead and Zinc Deposits: JAMES D. ROBERTSON.

On the Mud and Sand Dikes of the White River Miocene: E. C. CASE.

Editorial Comment; Review of recent Geological Literature; Recent Publications; Personal and Scientific News.

NEW BOOKS.

A travers le Caucase. ÉMILE LEVIER. Neuchâtel, Attinger Frères. Pp. 346.